The Human Eye and the Colourful World

Case Study Based Questions

Case Study 1

The triangular glass prism is a transparent object made of glass having two triangular ends and three rectangular sides. The opposite faces of a triangular glass prism are not parallel to one another. When a ray of light passes through a prism, it bends towards the base of prism. But when white light consisting of seven colours falls on a glass prism, each colour in it is refracted by a different angle, with the result that seven colours are spread out to form a spectrum. The red colour is deviated the least and the violet colour is deviated the maximum.

Read the above passage carefully and give the answer of the following questions:

Q1. Angle of deviation in a prism is the angle between:

a. incident and reflected ray
b. reflected and emergent ray
c. incident and emergent ray
d. incident and refracted ray

Q2. Which of the following phenomenon of light are involved in the formation of a rainbow?

a. Reflection, refraction and dispersion
b. Refraction, dispersion and total internal reflection
c. Refraction, dispersion and internal reflection
d. Dispersion, scattering and total internal reflection

Q3. Which of the following coloured light has the least speed in glass prism?

a. Violet
b. Yellow
c. Red
d. Green

Q4. The colour of light which undergoes least bending on passing through the glass prism is:

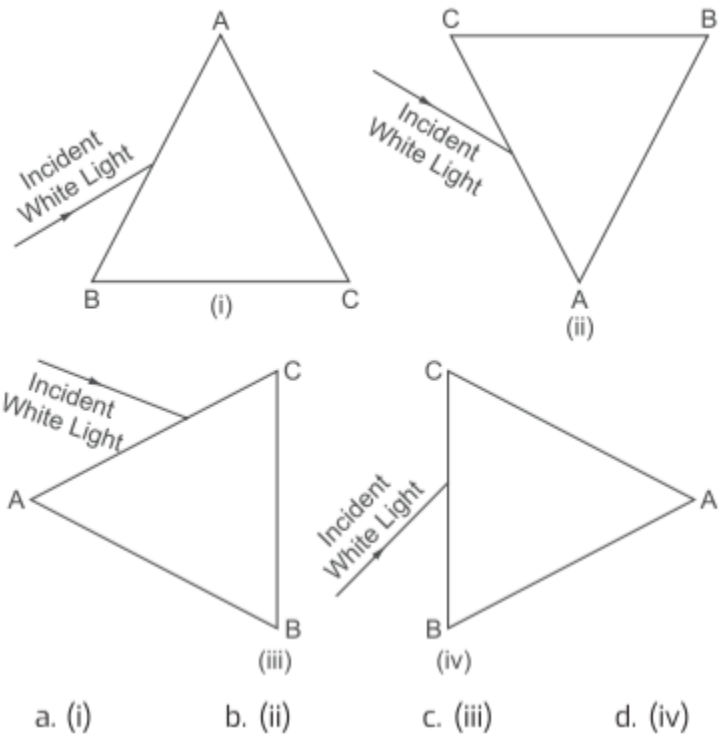
a. green

b. violet

c. red

d. blue

Q5. Based on the different orientations of a prism ABC given below, in which of the following cases, after dispersion, the third colour from the top corresponds to the colour of the sky?



a. (i) b. (ii) c. (iii) d. (iv)

Answers

1. (c) incident and emergent ray
2. (c) Refraction, dispersion and internal reflection
3. (a) Violet
4. (c) red
5. (b) (ii)

Case Study 2

We know that when light goes from one medium to another medium having different optical densities, then refraction of light rays (or bending of light rays) takes place. Now, in the atmosphere, we have air everywhere. But all the air in the atmosphere is not at the same temperature. Some of the air layers of the atmosphere are cold whereas other air layers of the atmosphere are comparatively warm (or hotter). Now the cooler air layers of the atmosphere behave as optically denser medium for light rays whereas the warmer air layers (or hotter air layers) of the atmosphere behave as optically rarer medium. for the light rays. So, in the same atmosphere we have air layers having different optical densities. And when light rays pass through the atmosphere having air layers of different optical densities, then refraction of light takes place. The refraction of light caused by the Earth's atmosphere (having air layers of varying optical densities) is called atmospheric refraction.

Read the above passage carefully and give the answer of the following questions:

Q1. With respect to atmospheric refraction which of the following point distinguish between cold air and hot air?

a. Cold air is denser than hot air
b. Hot air is lighter than cold air
c. Cold air has higher refractive index than hot air.
d. All of the above

Q2. What is the reason behind twinkling of Stars?

a. Dispersion of star light
b. Reflection of star light
c. Refraction of star light
d. All of the above

Q3. Why Sun appears flattened during sunrise and sunset?

a. Because Sun is closer to Earth
b. Because Earth is rotating
c. Because Earth is revolving
d. Because of atmospheric refraction

Q4. How much time from sunrise to sunset is lengthened because of atmospheric refraction?

a. 4 hours

b. 2 minutes

c. 4 minutes

d. 2 hours

Q5. When light rays from Stars enter into Earth's atmosphere, it travels from:

a. denser to rarer medium

b. rarer to denser medium

c. rarer medium to vacuum

d. denser medium to vacuum

Answers

1. (d) All of the above

Cold air is denser and heavier than hot air. Also, cold air has higher refractive index than hot air. Hence, all are true.

2. (c) refraction of star light

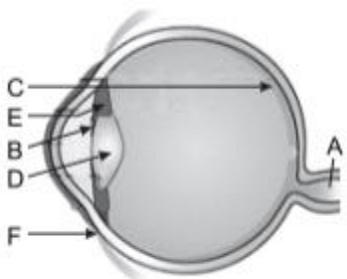
3. (d) The Sun appears flattened because of atmospheric refraction.

4. (c) The time from sunrise to sunset is lengthened by 4 minutes.

5. (b) When light rays from Stars enter into Earth's atmosphere, it travel from rarer to denser medium.

Case Study 3

Different organs of human eye are labelled as A to F.



The Structure of Human Eye

Study the diagram and answer the following questions:

Q1. Name the parts A, B, C, D and E.

Q2. What is the nature of image formed on the retina of the eye?

Q3. When light rays enter the eye, most of the refraction occurs at the:
(i) part D
(ii) part B
(iii) outer surface of part F
(iv) part E

Q4. Define power of accommodation.

Q5. What is aqueous humour and vitreous humour?

Answers

1. A-Optic nerve; B-Iris; C-Retina; D-Crystalline lens; E-Ciliary muscles

2. Real and inverted

3. (iii) outer surface of part F

4. The ability of eye lens to adjust its focal length is called power of accommodation.

5. The space between cornea and eye lens is filled with a watery liquid called aqueous humour, whereas vitreous humour is a transparent jelly-like substance filled between eye lens and retina.

Case Study 4

When light goes from one medium to another medium having different optical densities, then refraction of light rays takes place. All the air in the atmosphere is not at the same temperature. Some of the air layers of the atmosphere are cold (optically denser) whereas other layers of the atmosphere are comparatively warm (optically rarer). So, in the atmosphere we have air layers having different optical densities. Atmospheric refraction is the deviation of light from a straight line as it passes through the atmosphere due to the variation in air density. Such refraction can raise or lower, or stretch or shorten the images of distant objects and can also make distant objects appear to twinkle or shimmer.

Read the above passage carefully and give the answer of the following questions:

Q1. What is atmospheric refraction?

Q2. What causes atmospheric refraction?

Q3. Name the effects produced by atmospheric refraction.

Q4. Which has more refractive index-hot air or cold air?

Q5. How much time from sunrise to sunset is lengthened because of atmospheric refraction?

Answers

1. The refraction of light caused by the Earth's atmosphere (having air layers of varying optical densities) is atmospheric refraction.

2. It is caused due to the varying optical densities of different layers of Earth's atmosphere.

3. Twinkling of Stars, the Stars seem higher than they actually are and advanced sunrise and delayed sunset are some phenomenon produced by atmospheric refraction.

4. The refractive index of hot air is less than cold air because cold air is denser than hot air.

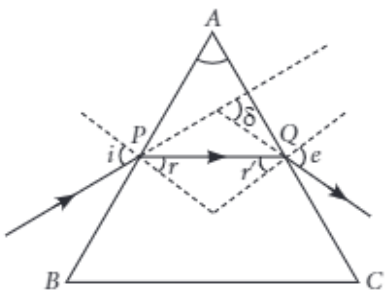
5. The sunrise appears 2 minutes early and sunset appears 2 minutes later due to atmospheric refraction. So, total time lengthened is 4 minutes.

Solutions for Questions 5 to 9 are Given Below

Case Study 5

Read the following and answer any four questions from 1(i) to 1(v).

A prism is a transparent refracting medium bounded by two plane surfaces inclined to each other at a certain angle. The refraction of light through a prism follows the laws of refraction. In the prism, refraction takes place on its refracting surface it means when the light enters the prism and when the light leaves the prism. The refraction through a prism is shown. Here, A is the angle of prism, $\angle i$ is the angle of incidence of the face AB and $\angle e$ is the angle of emergence at other face AC.



The incident ray suffers a deviation or bending through an angle δ due to the refraction through prism. This angle is called angle of deviation as shown in figure.

$$\angle i + \angle e = \angle \delta + \angle A$$

(i) The angle between the two refracting surfaces of a prism is called

(a) angle of prism (b) angle of incidence

(c) angle of deviation (d) angle of emergence

(ii) The angle between the incident ray and the emergent ray is called

(a) angle of emergence (b) angle of deviation

(c) angle of incidence (d) none of these

(iii) When a ray is refracted through a prism, then

(a) $\angle i = \angle \delta$ (b) $\angle i = \angle e + \angle \delta$

(c) $\angle \delta = \angle e$ (d) $\angle i > \angle r$

(iv) The angle of deviation depends on

(a) refractive index of prism (b) angle of incidence

(c) both (a) and (b) (d) none of these

(v) The rectangular surfaces of a prism are known as

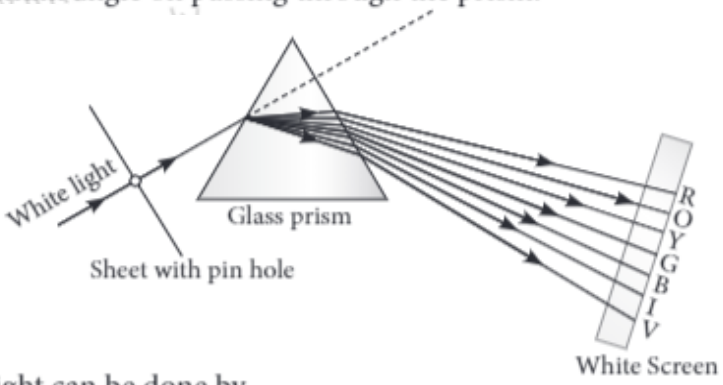
(a) reflecting surfaces (b) dispersing surfaces

(c) refracting surfaces (d) none of these.

Case Study 6

Read the following and answer any four questions from 2(i) to 2(v).

When white light is incident on one refracting surface of the prism, the light splits up into constituent colours-violet, indigo, blue, green, yellow, orange and red. The process of splitting of white light into its seven constituent colours is called dispersion. When the dispersed white light is made to fall on a screen, we get the band of seven colours is called the spectrum of white light. Red colour bends the least on passing through the prism and violet colour bends through maximum angle on passing through the prism.



(i) The splitting of white light can be done by

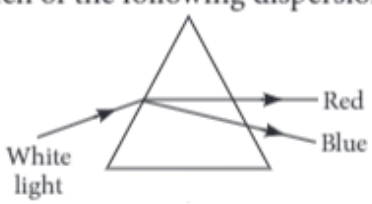
(a) lens (b) prism (c) mirror (d) none of these

(ii) Which property of light is used by prism to form a spectrum?

(a) Reflection (b) Refraction (c) Dispersion (d) Scattering

(iii) Which of the following dispersion is correct?

(a)



(b)

(c)

(d)

(iv) When a red light passes through a prism, it

(a) will not split (b) will split into seven colours

(c) will split into white colour (d) will split into many different colours.

(v) The spectrum produced by the white light by a prism is called

(a) pure spectrum (b) impure spectrum

(c) monochromatic spectrum (d) none of these.

Case Study 7

Read the following and answer any four questions from 3(i) to 3(v).

Light of all the colour travel at the same speed in vacuum for all wavelengths. But in any transparent medium (glass or water), the light of different colours travel with different speeds for different wavelength that means that the refractive index of a particular medium is different for different wavelength. As there is a difference in their speeds, the light of different colour bend through different angles. The speed of violet colour is maximum

and the speed of red colour is minimum in glass so, the red light deviates least and violet colour deviates most. Hence, higher the wavelength of a colour of light, smaller the refractive index and less is the bending of light.

$\lambda_r > \lambda_v$ and $r_n < v_n$. Also frequency, $\upsilon = \frac{c}{\lambda}$.

(i) Which of the following statements is correct regarding the propagation of light of different colours of white light in air?
(a) Red light moves fastest.
(b) Blue light moves faster than green light.
(c) All the colours of the white light move with the same speed.
(d) Yellow light moves with the mean speed as that of the red and the violet light.

(ii) Which of the following is the correct order of wavelength?
(a) Red > Green > Yellow
(b) Red > Violet > Green
(c) Yellow > Green > Violet
(d) Red > Yellow > Orange

(iii) Which of the following is the correct order of speed of light in glass?
(a) Red > Green > Blue
(b) Blue > Green > Red
(c) Violet > Red > Green
(d) Green > Red > Blue

(iv) Which colour which has maximum frequency
(a) Red
(b) Violet
(c) Blue
(d) Green

(v) Which of the following is the correct order of angle of deviation?
(a) Red > Green > Blue
(b) Blue > Yellow > Orange
(c) Orange > Red > Green
(d) Blue > Green > Violet

Case Study 8

Read the following and answer any four questions from 4(i) to 4(v).

The spreading of light by the air molecules is called scattering of light. The light having least wavelength scatters more. The sun appears red at sunrise and sunset, appearance of blue sky it is due to the scattering of light. The colour of the scattered light depends on the size of particles. The smaller the molecules in the atmosphere scatter smaller wavelengths of light. The amount of scattering of light depends on the wavelength of light. When light from sun enters the earth's atmosphere, it gets scattered by the dust particles and air molecules present in the atmosphere. The path of sunlight entering in the dark room through a fine hole is seen because of scattering of the sun light by the dust particles present in its path inside the room.

(i) To an astronaut in a spaceship, the colour of earth appears
(a) red
(b) blue
(c) white
(d) black

(ii) At the time of sunrise and sunset, the light from sun has to travel.
(a) longest distance of atmosphere
(b) shortest distance of atmosphere
(c) both (a) and (b)
(d) can't say

(iii) The colour of sky appears blue, it is due to the
(a) refraction of light through the atmosphere
(b) dispersion of light by air molecules
(c) scattering of light by air molecules
(d) all of these.

(iv) At the time of sunrise and sunset
(a) Blue colour scattered and red colour reaches our eye
(b) Red colour scattered and blue colour reaches our eye
(c) Green and blue scattered and orange reaches our eye
(d) None of these

(v) The danger signs made red in colour, because

(a) the red light can be seen from farthest distance (b) the scattering of red light is least

(c) both (a) and (b) (d) none of these

Case Study 9

Read the following and answer any four questions from 5(i) to 5(v).

Atmospheric refraction is the phenomenon of bending of light on passing through earth's atmosphere. As we move above the surface of earth, density of air goes on decreasing. Local conditions like temperature etc. also affect the optical density of earth's atmosphere. On account of atmospheric refraction, stars seen appear higher than they actual are; advanced sunrise; delayed sunset, oval appearance of the sun at sunrise and sunset; stars twinkle, planets do not.

(i) Due to atmospheric refraction, apparent length of the day

(a) increases (b) decreases (c) remains the same (d) all of these

(ii) Apparent position of the star appears raised due to

(a) atmospheric refraction (b) scattering of light

(c) both (a) and (b) (d) none of these

(iii) The sun appears oval shaped or flattened due to

(a) dispersion (b) scattering

(c) atmospheric refraction (d) cannot say

(iv) Twinkling of stars and non-twinkling of planets is accounted for by

(a) scattering of light (b) dispersion of light

(c) atmospheric refraction (d) none of these

(v) In absence of atmosphere, the colour of sky appears

(a) blue (b) black (c) red (d) yellow

HINTS & EXPLANATIONS

5. (i) (a): The angle between the two refracting surfaces of a prism is called angle of prism.

(ii) (b): The angle between the incident ray and the emergent ray is called angle of deviation.

(iii) (d): As the ray of light enters from rarer medium (air) to denser medium (glass), the angle of incidence is more than angle of refraction.

(iv) (c): More be the refractive index, more be the angle of deviation and it also depends on the refractive index of prism.

(v) (c): The refraction of light takes place through rectangular surfaces.

6. (i) (b)

(ii) (b)

(iii) (a): The deviation is maximum for violet and minimum for red, so option (a) is correct.

(iv) (a): The red light has a single wavelength and when enters a prism, it will not split into other different colours.

(v) (b): The boundaries of colours in the spectrum produced by prism are not sharp, so the spectrum is impure.

7. (i) (c): All the colours of the white light move with the same speed in air.

(ii) (c): The increasing order of wavelength of visible spectrum is

Violet < Indigo < Blue < Green < Yellow < Orange < Red

So, the correct order is

Yellow > Green > Violet

(iii) (b): The more be the wavelength, more be the speed.

(iv) (b): Frequency is inversely proportional to the wavelength. Violet has minimum wavelength among all these colours, so violet has maximum frequency.

(v) (b): The angle of deviation is more for more refractive index.

8. (i) (b): Light is scattered by the air molecules present in atmosphere.

(ii) (a): As the distance between us and sun is more at the time of sunrise and sunset.

(iii) (c): Due to the more scattering of blue colour by molecules of air.

(iv) (a): Red light being of largest wavelength blue scatter more, red scattered least.

(v) (c): Scattering is least but velocity of red light is more.

9. **(i) :** Due to atmospheric refraction, apparent length of the day increases by 4 minutes.

(ii) (a): Apparent position of the star appears raised due to atmospheric refraction.

(iii) (c)

(iv) (c): Twinkling of stars and non-twinkling of planets is on account of atmospheric refraction.

(v) (b): Due to no scattering of light.